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DRAWINGS ATTACHED

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(54) VENTING OF TYRE MOULDS

(71) We, UNIROYAL, INC., of 1230 Avenue of the Americas, Rockefeller Center, New York, State of New York 10020, United States of America, a corporation organised and existing under the laws of the State of New Jersey, one of the United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates generally to the venting of trapped gaseous medium in tyre moulds. More specifically, this invention relates to the venting of trapped gaseous medium from tyre moulds provided with a minimum number of vent openings.

Conventionally, tyre vulcanizing moulds are provided with a multitude of vent holes extending through various parts thereof. The number of such vent holes may be of the order of 300 or more depending on the size and design characteristics of the tyres to be moulded. The tyre rubber which follows expelled air into these conventional vents is called "vent rubber" and either breaks off in the vent holes during opening of the mould, or remains on the tyre as unsightly, pin-shaped, protrusions extending from the tyre surface.

Any vent rubber which remains in the vent holes must be removed therefrom and any vent rubber which extends from the tyre surface is usually trimmed, thus requiring additional operations and expense.

According to the present invention tyre moulding apparatus comprises a number of mould sections co-operating, when the mould is closed, to define by their inner surfaces a space for receiving a partly formed tyre; venting means leading from the space to provide an escape path for gaseous material trapped in the space; and vibrator means operable on at least one of the mould sections to move the inner surface thereof alternately toward and away from the outer surface of a tyre positioned in the space whereby gaseous material trapped between the tyre and the mould inner surface is expelled into the venting means.

Preferably the venting means are located solely along interfaces between adjacent mould sections.

Conveniently the inner surfaces of the mould sections which define the tread and/or sidewall portions of the tyre are provided with passageways joining localised cavities of the inner surface, and forming part of a route by way of which gaseous material may pass from a cavity to the venting means.

These measures allow gas to escape from the mould without the necessity of providing a multitude of vent holes, and thus avoids clogged holes and the trimming of vent rubber on the finished tyres.

Apparatus and methods according to the invention will now be described in more detail, by way of example, with reference to the accompanying drawings in which:—

Fig. 1 is a top plan view of a tyre vulcanizing press in accordance with the present invention;

Fig. 2 is a rear elevational view of the press according to Fig. 1, showing a pair of tyre moulds thereon;

Fig. 3 is a partial plan view of a tyre tread formed in a mould constructed according to the present invention;

Fig. 4 is a sectional view taken along line IV-IV of Fig. 1, showing the mould halves and the toe-ring members in closed position of the mould;

Fig. 5 is an enlarged sectional view taken along line V-V of Fig. 4;

Fig. 6 is another enlarged sectional view taken along line VI-VI of Fig. 4;

Fig. 7 is an enlarged sectional view taken along line VII-VII of Fig. 4;

Fig. 8 is an enlarged sectional view taken

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along line VIII-VIII of Fig. 4;

Fig. 9 is an enlarged sectional view taken along line IX-IX of Fig. 4;

Fig. 10 is an enlarged transverse sectional view through a portion of a tyre taken along line X-X of Fig. 3 showing a groove formed using apparatus of the present invention;

Fig. 11 is an enlarged transverse sectional view similar to Fig. 10 through a portion of another tyre showing a groove formed using apparatus of the present invention;

Fig. 12 is a transverse sectional elevation of a tyre mould press for practicing the present invention;

Fig. 13 is a view similar to that illustrated in Fig. 12, illustrating a modified version of the mould press for practicing the present invention;

Fig. 14 is a plan view of a tread portion of a tyre formed according to a method of the present invention;

Fig. 15 is a partial sectional elevational view of a portion of the mould used in fabricating the tyre illustrated in Fig. 14 with the view taken on the plane of the mould which would correspond to the plane indicated generally by line XV-XV of Fig. 14;

Fig. 16 is a plan view of a mould half, on a reduced scale, taken along line XVI-XVI of Fig. 4, and showing a venting arrangement according to the present invention.

Turning now to the drawings and first to Figs. 1 and 2, the conventional curing press 1 has a pair of vulcanizing moulds 2 and 3 having separable mould sections 2*a*, 2*b* and 3*a*, 3*b* respectively. The mould sections 2*a*, 2*b* have inner mould surfaces 2*a*′, 2*b*′ which define between themselves a space 4, as seen in Fig. 4, adapted to receive a tyre carcass to be formed into a tyre 5, as illustrated in Figs. 12 and 13.

Each of the vulcanizing moulds further includes conventional toe-ring members 6*a* and 6*b* for engaging the bead portion of the tyre in the conventional manner. The upper and lower mould sections 2*a* and 2*b* respectively, are relatively movable axially in the conventional manner with respect not only to each other but also the lower mould section 2*b* is movable with respect to the toe-ring member 6*b* while upper toe-ring member 6*a* moves with mould section 2a, said sections and toe-ring members forming between themselves interfaces 7*a*, 7*b* and 7*c*, seen in Fig. 4.

According to the present invention, each of the vulcanizing moulds, 2 and 3, comprises a vibrating means which preferably takes the form of a pair of vibrators 8*a* and 8*b*, mounted, respectively, on e.g., mould steam-back sections 2*c* and 2*d* which, in turn, are fixed to mould sections 2*a* and 2*b*, respectively. The vibrators are securely fixed to the respective mould steam-back sections (which may be resiliently mounted) so as to impart to the respective mould sections 2*a*, 2*b* a vibratory movement whenever the vibrators are activated. As shown in Figs. 1, 2 and 12, the vibrators 8*a* and 8*b* may be securely fixed to an exterior peripheral surface of mould steam-back sections 2*c* and 2*d* and preferably arranged to impart to the respective mould sections 2*a* and 2*b* an oscillatory movement substantially in a plane normal to the vertical axis of the mould. While the indicated mounting of the vibrators is preferred, it will be noted, of course, that the vibrators may be mounted at other convenient locations without departing from the invention. Thus, for example, the vibrators 8*a* and 8*b* may be mounted, instead, on other separable mould members such as the toe-ring members 6*a* and 6*b* respectively, as shown, for example, in Fig. 13. For certain mould constructions a single vibrator may suffice. It is also possible to apply ultrasonic or electromagnetic vibrators which are not mechanically connected to the mould but rather are only coupled thereto via sound waves and electromagnetic waves, respectively.

The mould is provided with venting means which provide escape paths for gaseous material trapped between the tyre and the inner mould surfaces when the mould is in the shaping stages and during final closing, i.e., when the mould sections 2*a*, 2*b*, 6*a* and 6*b* approach and are in the position illustrated in Fig. 4. Moulds with such venting means are described and claimed in our co-pending application No. 16153/68 (Serial No. 121162). Some venting means are located in the region of the existing interfaces 7*a*, 7*b* and 7*c* between the respective mould sections. These venting means preferably take the form of grooves 9 (hereinafter referred to as "interface scratch vents") cut in the surface of one of the mould sections at its interface with another of said mould sections. Thus, as seen in Figs. 4, 5, 6 and 16, interface scratch vents 9 are provided in the interface surfaces of the respective mould sections. These scratch vents 9 extend radially and are distributed circumferentially over the respective surfaces at interfaces 7*a*, 7*b* and 7*c*. Preferably, these interface scratch vents are provided at each interface, circumferentially spaced approximately ¼″ apart, or of sufficient number to adequately exhaust the trapped gases. These interface scratch vents are preferably V-shaped, as seen in Figs. 5 and 6, and are preferably approximately 0,020 to 0.030 inches deep having a central angle of approximately 60°. The innermost portions of the radial interface scratch vents communicates with the interior of the cavity 4, while the opposite end of each interface scratch vent communicates preferably with the at-

mosphere.

Additional, preferably circumferentially extending vents 9*a*, are provided at the inner mould surface junction of the mould sections 2*a* and 2*b* with the toe-rings 6*a* and 6*b*, respectively. The interface scratch vents 9, in this region, communicate with and are at substantially right angles to the circumferential vents 9*a*.

Scratch vents 9 and circumferential vents 9*a*, it will be seen, facilitate the escape of gaseous material trapped between the outer surface of a tyre 5 and portions of the inner mould surfaces 2*a*′ and 2*b* during shaping and mould closing stages and during the final moulding and curing process.

When the mould is closed a partially formed, raw tyre 5, located in the cavity 4, is pressed, by way of a conventional curing bag 10 having internal pressure applied thereto, against the sidewall and the tread forming portions of the inner mould surfaces 2*a*′ and 2*b*′. When portions of the tyre 5 are so pressed against tread groove forming projections 11, it is possible that air trapped in compartments formed by such projections, the outer tyre surface, and the inner mould surfaces, will not be able to reach the scratch vents 9, 9*a* previously described, unless additional lateral internal passages are provided. Accordingly passages 11*a* (hereinafter referred to as Across Tread Lateral vents, or ATL vents) are bored laterally through the circumferentially extending ribs 11, to provide lateral air passages therethrough, for permitting air trapped in spaced regions of the tyre mould to escape to the region of the parting line, i.e., interface 7*a*. It will be understood that the design forming elements 14 are provided with conventional air passages (not shown) therethrough. When moulding pressure is applied in the conventional manner via the bag 10, some of the tyre rubber will inevitably flow into the ATL vents 11*a*. Fig. 11 shows ATL filling vent rubber 11*a*″ broken upon removal of the tyre from the mould, while Fig. 10 shows vent rubber 11*a*‴, which did not entirely fill the ATL vent, extending from both sides of the tread groove toward the middle.

Fig. 3 shows a portion of a tyre tread cured in a mould according to the present invention with the ATL vent rubbers 11*a*‴ in the circumferentially extending groove portions of the tread.

In order to facilitate the escape of the gaseous material also from the sidewall regions of the tyre, additional passageways are preferably provided. Thus, for the same reasons as described above in connection with the ATL vents, axial slots 12*a* are provided through the circumferentially extending shoulder-groove-forming-projections 12. Co-operating with these axial slots 12*a*, are provided a plurality of circumferentially distributed, axially extending, interior scratch vents 12*a*′, illustrated in Figs. 4, 7 and 8. These slots and scratch vents all facilitate passage of otherwise trapped air from the sidewall regions of the mould toward the parting line interface 7*a*. In the tread design for a large size tyre as illustrated, for example, in Fig. 14, the tread marks 12*a*″ which correspond to scratch vents 12*a*, are shown. It is seen that vents 12*a*′ provide air passages, see Fig. 15, laterally through the entire tread pattern, connecting the insert configuration 14 to the circumferentially extending shoulder grooves 13 and also to the mould parting line at interface 7*a*. It is to be understood that vents 12*a*′ are not necessary in all cases but are preferred for moulding of tyres having certain design, size or shape characteristics which prevent adequate lateral flow of gas, e.g., with heavy-duty, wide-ribbed tyres having large spans of tread surface between the insert regions and the grooves.

Additionally, for further facilitating the flow of trapped air within the mould cavity, there may be provided a plurality of radially extending sidewall flutes 15, distributed circumferentially along the inner mould surfaces 2*a*′ and 2*b*′, respectively, adjacent to the corresponding toe-ring 6*a*, 6*b*. As seen in Fig. 4, these flutes 15 communicate directly with circumferentially extending vents 9*a*.

It is generally desirable to taper the ATL vents so that they have a smaller diameter end for the purpose of providing a relatively weaker section for the moulded ATL vent-rubber to break at the adjoining tread rib. It will be noted that the ATL vents 11*a* act not only as air channels for directing the flow of air in desired directions but may also act as air reservoirs for any residual air which cannot otherwise escape.

The mould sections are preferably vibrated at a relatively high frequency and at a relatively low amplitude during the shaping stages of closing, and throughout the remaining closing cycle. Because the elastomeric raw tyre carcass in the mould is unable to respond to the vibrations in the same manner as the mould structure itself, there results a relative difference in movement between tyre outer surface portions and corresponding mould inner surface portions. Thus, the vibrating mould sections have portions which move alternately toward and away from corresponding adjacent outer surface portions of a tyre 5 positioned in the cavity 4. The rapid, successive, movements of adjacent surfaces toward and away from each other act, during that part of each cycle when adjacent surface portions are spaced from each other, to permit air to move through the space created thereby, and

during that part of each cycle when the surfaces move toward each other, to expel such air into the next adjacent space and eventually out through the interface scratch vents located in the interface regions. Vibrations having an amplitude in the range of 0.0005 to 0.050 inches have been found quite satisfactory in producing the above described results.

Vibrators of the following description have been used sucessfully in practicing the present invention with tyre moulds for conventional passenger car tyres:

No. CD 35, Vibrolators (registered trademark) manufactured by the Martin Engineering Company, Neponset, Illinois. The preferred frequency range of vibration is approximately 5,000 cycles per minute while successful operation has been accomplished with frequencies in the range of 2,000 through 10,000 cycles per minute. Other conventional vibrating devices may, of course, be used instead of the above described devices. The latter work on the principle of a ball-weight spun around and around, inside an outer race, by compressed air or steam, so as to generate powerful, high-frequency, all directional (substantially in one plane) vibrations. The preferred mounting is such that the circling ball moves substantially in a plane normal to the axis of the tyre mould.

The particular type of vibrator described herein does not form a part of this invention, and many different readily available vibrating devices can be used. Thus, it is necessary only that the vibrating mechanism used vibrates either the mould with respect to the tyre located therein, or the tyre with respect to the mould surrounding it, in such a manner as to result in a vibration response of the tyre with respect to the mould which is either of a different phase, a different amplitude, a different frequency, or all three of these. It is important only that a relative movement in successively alternate directions is produced between corresponding adjacent surface portions of the tyre and the mould surface, so as to provide paths for air movement, on the one hand, and to expel such air, on the other hand. It will be obvious to those skilled in the art that the vibration response of the heavy, generally rigid mould structure will be, particularly at relatively high frequencies, substantially different from the response of the elastomeric tyre material located therein.

As used herein, the term "vibration" is intended to include also oscillatory movement.

To mould a tyre using this apparatus a partially formed, raw tyre is placed into the mould cavity 4 in the conventional manner. The mould is closed in the conventional manner and also as is conventional, pressure is applied to the interior of the tyre, expanding the latter outwardly against the sidewall and tread forming portions of the mould surfaces 2*a*′ and 2*b*′. In the shaping stage during the closing of the mould sections, with the tyre therebetween, and during the final closing for moulding of the tyre outer surface, as described, vibrator means 8*a* and 8*b* are activated and vibrate the mould sections with respect to the tyre located therebetween, relatively moving outer surface portions of the tyre and corresponding adjacent inner surface portions of the mould member toward and away from each other in rapid succession whereby gaseous material trapped between such surface portions can escape toward the interface regions 7*a*, 7*b* and 7*c* and there be expelled or escape to the atmosphere.

An additional advantage derived from the apparatus according to the present invention is the capability of facilitating removal of the finished tyre from the mould by again vibrating the mould with respect to the tyre so as to essentially vibrate the tyre out of the mould while the mould is being opened.

WHAT WE CLAIM IS:—

1. Tyre moulding apparatus comprising a number of mould sections co-operating, when the mould is closed, to define by their inner surfaces a space for receiving a partly formed tyre; venting means leading from the space to provide an escape path for gaseous material trapped in the space; and vibrator means operable on at least one of the mould sections to move the inner surface thereof alternately toward and away from the outer surface of a tyre positioned in the space whereby gaseous material trapped between the tyre and the mould inner surface is expelled into the venting means.

2. Tyre moulding apparatus according to claim 1 in which the venting means are located solely along interfaces between adjacent mould sections.

3. Tyre moulding apparatus according to claims 1 and 2 in which the inner surfaces of the mould sections which define the tread and/or sidewall portions of the tyre are provided with passageways joining localised cavities of the inner surface, and forming part of a route by way of which gaseous material may pass from a cavity to the venting means.

4. Tyre moulding apparatus according to any one of the preceding claims in which the mould sections comprise upper and lower sections defining between themselves a generally toroidally shaped space, at least a portion of the venting means being provided along the interface between the upper and lower sections.

5. Tyre moulding apparatus according to claim 4 and including a pair of toe-ring

mould sections located centrally with respect to the upper and lower sections and having interfaces therewith, venting means being provided along said interfaces.

6. Tyre moulding apparatus according to claim 4 or claim 5 in which the vibrator means comprises a pair of vibrator mechanisms operatively connected, respectively, to the upper and lower mould sections.

7. Tyre moulding apparatus according to claim 5 in which the vibrator means is operatively connected to the toe-ring sections.

8. Tyre moulding apparatus according to any one of the preceding claims in which the vibrator means comprises a high-frequency, low-amplitude vibrator.

9. Tyre moulding apparatus according to any one of the preceding claims in which the mould section or sections on which the vibrator means is operable is or are resiliently supported.

10. Tyre moulding apparatus substantially as herein described and as illustrated in Figs. 1, 2, 4 to 9 and 16; or Fig. 12; or Fig. 13; or Fig. 15 of the accompanying drawings.

11. A method of moulding a tyre comprising inserting a partly formed tyre into an open mould having a number of relatively movable mould sections, closing the mould by moving one or more of the mould sections to bring the interfaces thereof into contact, and causing vibratory relative movement to occur between at least one of the mould sections and the tyre within the mould to cause gaseous material trapped between the mould inner surface and the tyre outer surface to pass to venting means leading from the inner surface.

12. A method according to claim 11 in which the relative movement occurs through vibrating at least one of the mould sections.

13. A method according to claim 12 in which the vibration takes place at high frequency and low amplitude.

14. A method according to claim 13 in which the frequency is from 2,000 to 10,000 cycles per minute, and the amplitude is from 0.0005 to 0.05 inches.

15. A method of moulding a tyre, the method being substantially as herein described with reference to the accompanying drawings.

URQUHART-DYKES & LORD,
Chartered Patent Agents,
Agents for the Applicants,
12 South Parade, Leeds 1,
— and —
Columbia House, 69 Aldwych,
London, W.C.2.

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1211613 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

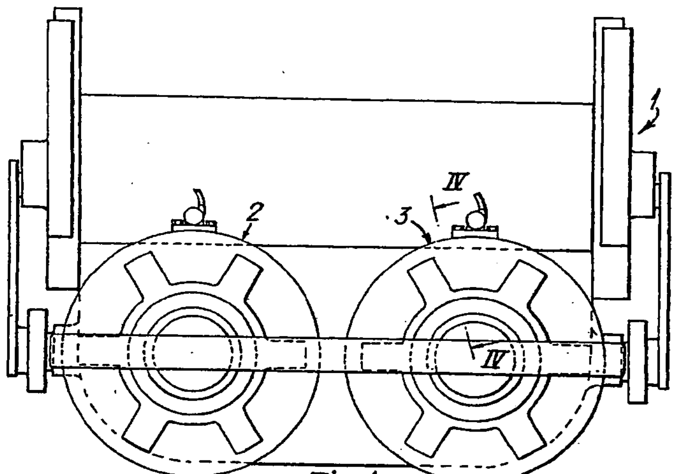


Fig. 1.

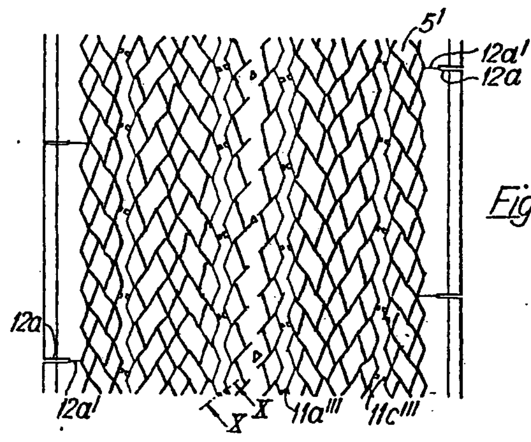


Fig. 3.

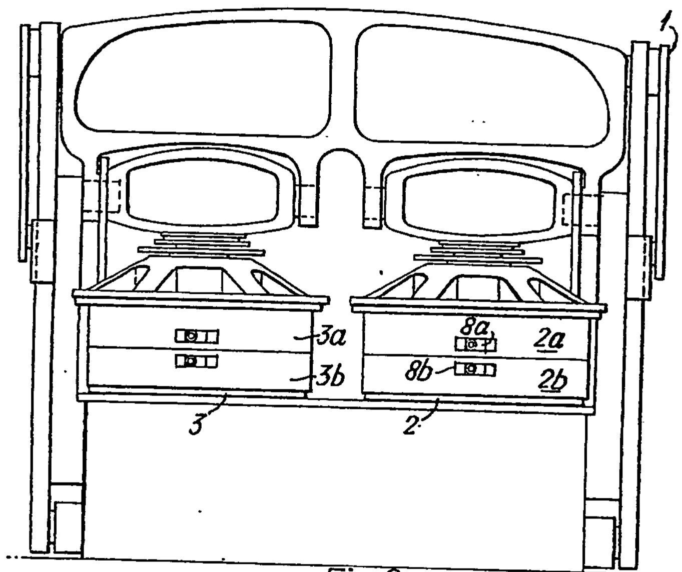


Fig. 2.

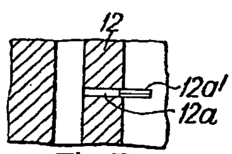


Fig. 7.

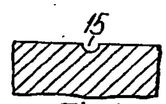


Fig. 9.

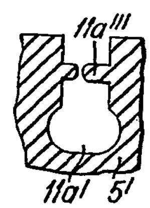


Fig. 10.

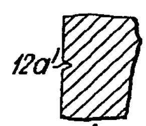


Fig. 8.

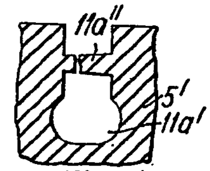


Fig. 11.

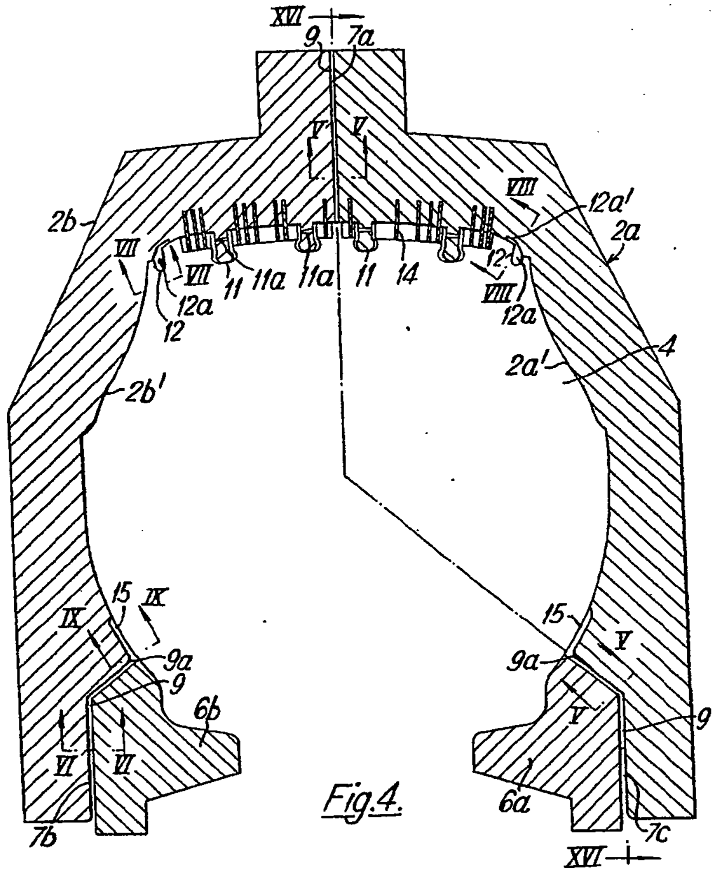
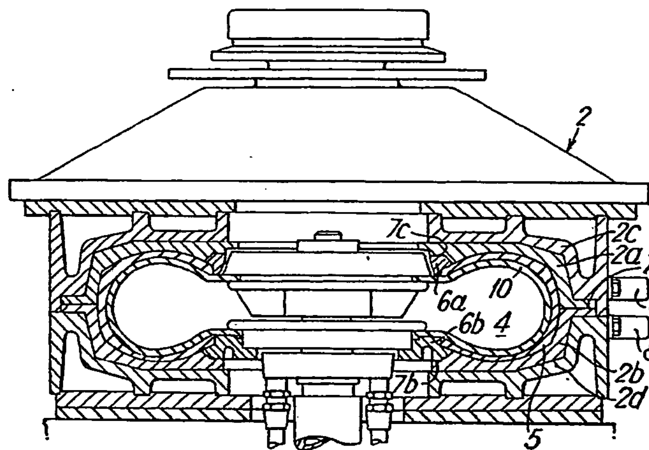


Fig.4.

Fig.6.

Fig.5.


2
7c
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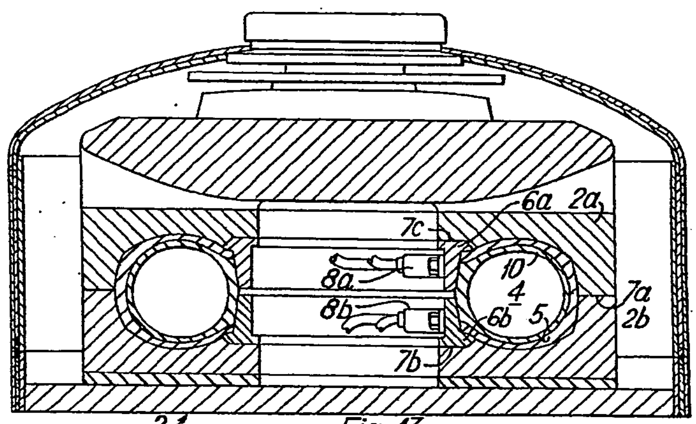
7a
8a
6a
10
6b
4
8b
2b
7b
2d
5

Fig. 12.


6a
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7c
10
8a
4
7a
8b
6b
5
2b
7b
2

Fig. 13.

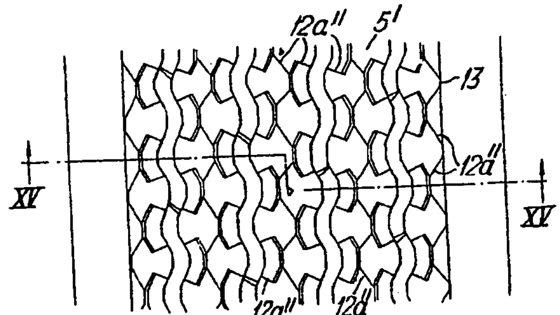
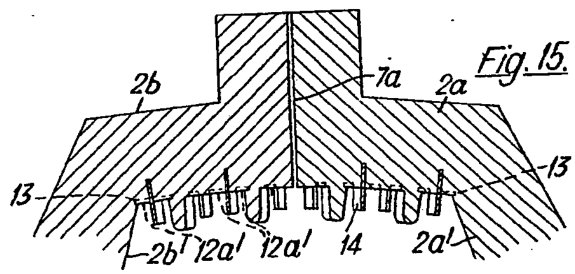


Fig. 14.

Fig. 15.



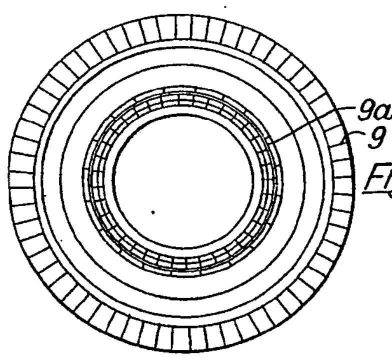


Fig. 16.